Claims

1. An energy recovery driving circuit for driving a load with a certain capacitance, comprising:

a resonant inductor connected to the load for allowing a charge and/or discharge current to be applied to the load to flow through the resonant inductor;

a primary coil of a transformer, connected to the resonant inductor, the primary coil being connected to both the resonant inductor and the load so as to allow the charge and/or discharge current to flow through the primary coil when the charging and/or discharge current flows through the load through the resonant inductor;

at least one secondary coil of the transformer, coupled to the primary coil; and

an energy recovery unit for generating a current according to the predetermined number of turns of the secondary coil in the secondary coil to allow the current flowing through the secondary coil to be recovered to a supply voltage source.

2. The energy recovery driving circuit according to claim 1, wherein the energy recovery unit comprises:

first switching means connected to a supply voltage for receiving a first switching signal to allow a resonance current used to charge the load to flow through the resonant inductor from the supply voltage; and

second switching means connected to ground for receiving a second switching signal to allow a resonance current used to discharge the load to flow through the resonant inductor from the load.

3. The energy recovery driving circuit according to claim 2, further comprising a sustain driving unit for supplying a sustain voltage to the load;

wherein the sustain driving unit comprises,

third switching means connected between the supply voltage and the load to supply the sustain voltage to the load by reception of a third switching signal after the load is charged by the resonance current used to charge the load,

fourth switching means connected between the ground and the load to apply a ground voltage to the load by reception of a fourth switching signal after the load is discharged by the resonance current used to discharge the load,

a third body diode connected in parallel with the third switching means to prevent a charged voltage of the load from increasing to be greater than the supply voltage when the load is charged, and

a fourth body diode connected in parallel with the fourth switching means to prevent a discharged voltage of the load from decreasing to be less than the ground voltage when the load is discharged,

wherein the resonance current is recovered to a supply voltage source through the third body diode after the load is charged to be greater than or equal to the supply voltage, and

the resonance current is recovered to the ground through the fourth body diode after the load is discharged to be less than or equal to the ground voltage.

4. The energy recovery driving circuit according to claim 3, wherein:

the primary coil is connected between the resonant inductor and the load, the first switching means is connected between the supply voltage and the resonant inductor, and the second switching means is connected between the resonant inductor and the ground;

the energy recovery unit further comprises first and second diodes for conducting a current in a direction of the supply voltage source;

the secondary coil comprises;

a first secondary coil connected in series with the first diode between the supply voltage and the ground and coupled to the primary coil so as to allow a charge current to flow through the supply voltage source when the charge current flows through the primary coil, and

a second secondary coil connected in series with the second diode between the supply voltage and the ground and coupled to the primary coil so as to allow a discharge current to flow into the supply voltage source when the discharge current flows through the primary coil.

5. The energy recovery driving circuit according to claim 3, wherein:

the primary coil has a first end connected to the resonant inductor and a second end connected to both the first and second switching means, the first switching means is connected between the supply voltage and the primary coil, and the second switching means is connected between the primary coil and the ground;

the energy recovery unit further comprises a first diode for conducting a current in an opposite direction of the ground voltage from the ground voltage and a second diode for conducting a current in a direction of the supply voltage; and

the secondary coil comprises,

a first secondary coil connected in series with the first diode between the primary coil and the ground, and coupled to the primary coil so as to allow a charge current to flow out from the ground when the charge current flows through the primary coil, and

a second secondary coil connected in series with the second diode between the supply voltage and the primary coil, and the ground voltage and coupled to the primary coil so as to allow a discharge current to flow into the supply voltage source when the discharge current flows through the primary coil.

6. The energy recovery driving circuit according to claim 3, wherein:

the primary coil has a first end connected to the resonant inductor and a second end connected to both the first and second switching means, the first switching means is connected between the supply voltage and the primary coil, and the second switching means is connected between the primary coil and the

ground;

the energy recovery unit further comprises a first diode for conducting a current in an opposite direction of the ground and a second diode for conducting a current in a direction of the supply voltage; and

the secondary coil is provided with a first end connected to the primary coil and a second end connected to a common end of the first and second diodes, and is coupled to the primary coil for allowing a charge current to flow out from the ground when the charge current flows through the primary coil and allowing a discharge current to flow into the supply voltage source when the discharge current flows through the primary coil.

7. The energy recovery driving circuit according to claim 3, wherein:

the primary coil has a first end connected to the resonant inductor and a second end connected to both the first and second switching means, the first switching means is connected between the supply voltage and the primary coil, and the second switching means is connected between the primary coil and the ground;

the energy recovery unit further comprises a first diode for conducting a current in an opposite direction of the ground and a second diode for conducting a current in a direction of the supply voltage; and

the secondary coil comprises,

a first secondary coil connected in series with the first diode between a common end of the primary coil and the resonant inductor and the ground, and coupled to the primary coil so as to allow a charge current to flow out from the ground when the charge current flows through the primary coil, and

a second secondary coil connected in series with the second diode between the supply voltage and the common end of the primary coil and the resonant inductor, and coupled to the primary coil so as to allow a discharge current to flow into the supply voltage source when the discharge current flows through the primary coil.

8. The energy recovery driving circuit according to claim 3, wherein:

the primary coil has a first end connected to the resonant inductor and a second end connected to both the first and second switching means, the first switching means is connected between the supply voltage and the primary coil, and the second switching means is connected between the primary coil and the ground;

the energy recovery unit further comprises a first diode for conducting a current in an opposite direction of the ground and a second diode for conducting a current in a direction of the supply voltage; and

the secondary coil is connected between a common end of the primary coil and the resonant inductor and a common end of the first and second diodes, and is coupled to the primary coil for allowing a charge current to flow out from the ground when the charge current flows through the primary coil and allowing a discharge current to flow into the supply voltage source when the discharge current flows through the primary coil.

9. The energy recovery driving circuit according to claim 3, wherein:

the primary coil has a first end connected to the resonant inductor and a second end connected to the load, the first switching means is connected between the supply voltage and the resonant inductor, and the second switching means is connected between the resonant inductor and the ground;

the energy recovery unit further comprises a first diode for conducting a current in an opposite direction of the ground and a second diode for conducting a current in a direction of the supply voltage; and

the secondary coil comprises,

a first secondary coil connected in series with the first diode between a common end of the primary coil and the load and the ground, and coupled to the primary coil so as to allow a charge current to flow out from the ground when the charge current flows through the primary coil, and

a second secondary coil connected in series with the second diode between the supply voltage and the common end of the primary coil and the load, and coupled to the primary coil so as to allow a discharge current to flow into the supply voltage source when the discharge current flows through the primary coil.

10. The energy recovery driving circuit according to claim 3, wherein:

the primary coil has a first end connected to the resonant inductor and a second end connected to the load, the first switching means is connected between the supply voltage and the resonant inductor, and the second switching means is connected between the resonant inductor and the ground;

the energy recovery unit further comprises a first diode for conducting a current in an opposite direction of the ground and a second diode for conducting a current in a direction of the supply voltage; and

the secondary coil is connected between a common end of the primary coil and the load and a common end of the first and second diodes, and is coupled to the primary coil for allowing a charge current to flow out from the ground when the charge current flows through the primary coil and allowing a discharge current to flow into the supply voltage source when the discharge current flows through the primary coil.

11. The energy recovery driving circuit according to any of claims 4, 5, 6, 9 and 10, wherein the resonant inductor is a leakage inductance of the transformer.

12. The energy recovery driving circuit according to any of claims 4, 5 and 6, wherein the number of turns of the secondary coil is greater than or equal to two times that of the primary coil.

13. The energy recovery driving circuit according to any of claims 7, 8, 9 and 10, wherein the number of turns of the secondary coil is greater than or equal

to that of the primary coil.

14. An energy recovery driving circuit for driving a load with a certain capacitance, comprising:

a first resonant inductor connected to the load for allowing a charge and/or discharge current to be applied to the load to flow through the first resonant inductor;

a primary coil of a first transformer, connected to the first resonant inductor, the first transformer primary coil being connected to both the first resonant inductor and the load so as to allow the charge and/or discharge current to flow through the first transformer primary coil when the charge and/or discharge current flows through the load through the first resonant inductor;

at least one secondary coil of the first transformer, coupled to the first transformer primary coil;

a first energy recovery unit for generating a current according to the predetermined number of turns of the first transformer secondary coil in the first transformer secondary coil to allow the current flowing through the first transformer secondary coil to be recovered to a supply voltage source;

a second resonant inductor connected to the load for allowing a charge and/or discharge current to be applied to the load to flow through the second resonant inductor;

a primary coil of a second transformer, connected to the second resonant inductor, the second transformer primary coil being connected to both the first resonant inductor and the load so as to allow a charge and/or discharge current to flow through the second transformer primary coil when a charge and/or discharge current flows into the load through the second resonant inductor;

at least one secondary coil of the second transformer, coupled to the second transformer primary coil; and

a second energy recovery unit for generating a current according to the predetermined number of turns of the second transformer secondary coil in the

second transformer secondary coil to allow the current flowing through the second transformer secondary coil to be recovered to the supply voltage source,

wherein the first and second energy recovery units are symmetrically arranged at both ends of the load.

15. The energy recovery driving circuit according to claim 14, wherein each of the first and second energy recovery units comprises:

first switching means connected to a supply voltage for receiving a first switching signal to allow a resonance current used to charge the load to flow through the resonant inductor from the supply voltage; and

second switching means connected to ground for receiving a second switching signal to allow a resonance current used to discharge the load to flow through the resonant inductor from the load.

16. The energy recovery driving circuit according to claim 14, further comprising first and second sustain driving units for supplying a sustain voltage to the load;

wherein the first and second sustain driving units each comprises,

third switching means connected between the supply voltage and the load to supply the sustain voltage to the load by reception of a third switching signal after the load is charged by the resonance current used to charge the load,

fourth switching means connected between the ground and the load to apply a ground voltage to the load by reception of a fourth switching signal after the load is discharged by the resonance current used to discharge the load,

a third body diode connected in parallel with the third switching means to prevent a charged voltage of the load from increasing to be greater than the supply voltage when the load charged, and

a fourth body diode connected in parallel with the fourth switching means to prevent a discharged voltage of the load from decreasing to be less than the ground voltage when the load is discharged,

wherein the resonance current is recovered to the supply voltage source through the third body diode after the load is charged to be greater than or equal to the supply voltage,

the resonance current is recovered to the ground through the fourth body diode after the load is discharged to be less than or equal to the ground voltage,

the fourth switching means of the second sustain driving unit is turned on during an operating mode in which the third switching means of the first sustain driving unit is turned on, and

the third switching means of the second sustain driving unit is turned on during an operating mode in which the fourth switching means of the first sustain driving unit is turned on.

17. The energy recovery driving circuit according to any of claims 14, 15 and 16, wherein the first transformer having the first transformer primary coil and the first transformer secondary coil, and the second transformer having the second transformer primary coil and the second transformer secondary coil are integrated into a single transformer.

18. The energy recovery driving circuit according to claim 3, wherein the fourth switching means is turned on by reception of a charge boosting signal to boost a current of the resonant inductor before a resonance current used to charge the load flows through the fourth switching means, and the third switching means is turned on by reception of a discharge boosting signal to boost the current of the resonant inductor before a resonance current used to discharge the load flows through the third switching means, thus enabling the energy recovery driving circuit to be driven in a current injection manner.